

Teaching Biology Using Real World Pest Management Strategies Life Science Curriculum for Grades 9 – 12

Concepts Covered: What makes a pest a pest, IPM, what an organism needs

Overview and Background: The purpose of this lesson is twofold; to increase scientific literacy and to increase knowledge of Integrated Pest Management. Scientific literacy is the ability to critically evaluate information, draw conclusions, and communicate them to others. This includes the evaluation of the research and conclusions of others. IPM or Integrated Pest Management, is the use of habitat alteration, resource elimination, sanitation, traps, pesticides, and more. It looks at pesticides as part of a toolbox rather than the first option, not eliminating them, but using them carefully. This is particularly vital in an urban environment.

Grade Level: High School and/or Adult Informal Education

Standards:

Next Generation Science Standards:

HS-LS2-6: Use Claims, Evidence, and Reasoning to evaluate the concept that changes in an ecosystem result in changes in populations

HS-LS2-7: Design, evaluate, and refine plans to reduce human impact on an ecosystem and its components.

HS-LS2-8: Evaluate the role of group behavior on an individual and species' chance to survive and reproduce.

Colorado Science Standard:

HS-2-2: Use Claims, Evidence, and Reasoning to evaluate the idea that living organisms interact with biotic and abiotic components of their environments

Common Core Standard:

CCSS.ELA-Literacy.CCRA.L.4: Determine or clarify the meaning of unknown and multiple-meaning words and phrases by using context clues, analyzing meaningful word parts, and consulting general and specialized reference materials, as appropriate.

Objectives: Students will be able to

- Analyze theoretical situations and determine which limiting resources different organisms need to survive in their environment.

- Define a pest using evidence to support their claims
- Design a three pronged Integrated Pest Management strategy that demonstrates knowledge of an organism’s limiting resources.
- Produce a glossary of upper level terminology used in IPM through inference and collaboration.

Materials:

- A board to put key terms on, Scissors, Sticky notes, Poster paper (enough for each pair to have one poster), writing utensils, two pages of lined paper for each student, enough copies of the Pest/Not a Pest pictures for each pair of students to have three, glue sticks or tape, a copy of “Sample Pest Management Instructions” for each student.

Instructional Planning: Print off the Pest/not a Pest pictures before class and cut them apart to hand out in class. There should be enough for each pair to have three, have a copy of the included “Sample Pest Management Instructions” to hand out to each student for homework

Procedure:

	Step	Teacher Activity/Instructions	Student Activity/Instructions
Engage 10 min	1	Put objectives on board: - Analyze a situation and identify limiting resources - Use evidence to support a pest/ not a pest claim - Design a three pronged pest management (IPM) strategy	Read the class objectives
	2	Activate prior knowledge: “There are three things that every living organism needs to survive. Scientifically we refer to these as limiting resources. Me, you, a	Name the three things organisms need to survive (energy/nutrients, water, shelter/a place to grow) and put them on the board

		daffodil, a deer, what are these limiting resources?"	
	3	Facilitate	Brainstorm "pests," everyone writes at least one on the board.
	4	Select 5 common pests off the board (at least one plant). Have students answer two question below each pest name. "Where does this pest live? What does this pest eat?"	Answer questions on the board. Us this information to define "pest" as a class. (Similar to: A pest is any living thing that disrupts human activity or damages the environment)
Explore 12 min	5	Demonstrate the next activity (pest/not a pest posters) using example in written form on the board: house cricket, lives in moist crevices, eats crumbs and clothes. Claim: it is a pest, Evidence: sings at night, eats clothes, unsanitary, reasoning: interrupts sleep, cannot wear holey clothes. (have students give evidence and reasoning)	Listen to teacher, participate in completion of example on board.
	6	Split class into pairs, either pre-existing seating pairs or new pairs that will collaborate well. Pass out poster paper and pest/not a	Write names on backs of poster. Cut out pictures and attach to poster, spread out with enough room for writing and drawing.

		pest pictures (three per student pair).	
	7	Facilitate, make scissors, drawing supplies, glues sticks, available.	<ul style="list-style-type: none"> - Draw the described situation around the image - Next to the drawing, write if the situation is the result of human interference - Write why the organism is there, include limiting resources - Make a written claim, is the organism a pest or not a pest - Support this claim with at least three written pieces of evidence
Explain 8 min	8	Pass out sticky notes, at least three per student. Facilitate (What kinds of interactions does the organism have with humans? Keep our definition of a pest in mind. Look at the limiting resources for the pest.)	Use sticky notes to agree or disagree with the claims (pest/not a pest) on other people's posters, back up your claims
	9	Facilitate (Did your peers agree or disagree with you? Did they bring up any ideas you didn't think about?)	Re-evaluate your own poster, make any changes you feel are needed.
Elaborate 15 min	10	Put glossary terms (included below) on the board. Which and how many terms are in	Complete a lesson glossary of the terms that have been put on the board. Define

		the glossary is dependent on time, education level, and teacher choice. Facilitate by asking guiding questions (What does integrated mean / suggest? Perhaps more than one thing working together? What does Pest mean? Is it a broad or specific term? What does Management mean? Is it the same as elimination? Some words may require more explicit explanations.)	Integrated Pest Management as a class. (Using what we know about the life cycles of pests to create an economical pest management plan, using a variety of techniques, with the least possible damage to humans and the environment.)
	11	Facilitate (Is there something humans do that the potential pest takes advantage of? Could we change that behavior/ habit? For example: House Crickets: clean up food messes immediately, store food in hard plastic containers, store food on high shelves)	Develop a three pronged management method using several different approaches for one of the pests on your poster in your science journal or a separate piece of paper. You may do this as a group, but each student should have separate papers to turn in.
Evaluate 5-10 in class or HW	12	Pass out graphic organizers for the homework or as in-class work. This does not have to be quiet work time.	As homework, or in class as a part of a second lesson, compare “Recommended’ Pest Management Strategies” with your own

	Evaluate poster, glossary of terms, IPM method and homework using the attached rubric.	IPM method for controlling a pest that you previously developed. Use the graphic organizer you are given.
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Assessment: For formal educational situations only

Formative Assessment: Sticky notes, Posters, discussion contribution, ability to work in pairs

Summative Assessment: Posters, Re-assessment of strategies, Three-pronged management method and comparison with “Sample Pest Management Strategies.”

Anticipated misconceptions/Alternative conceptions:

- Once an organism is classified as a pest it is always a pest in every time and place: There are no strict right or wrong answers to any of the Pest/Not a Pest situations. In some situations one side is more easily defensible than the other, but in pest management the classification of a “pest” is relative. Some students may struggle with this. Tell the students to go ahead and defend the opinion they agree with, not the class consensus or what they think you want to hear.
- Pesticides and IPM strategies are not compatible: IPM does not ban the use of pesticides, it simply discourages their over use and encourages looking for cheaper, less damaging alternatives first, and then using pesticides cautiously. For example, when ants invaded my bedroom I stopped eating in my room, I started keeping my food in airtight containers, and I laid out inexpensive and fairly safe ant traps (I had no pets or children to play with the traps at the time.)

Accommodations/modifications for special needs, ELL, and gifted/talented:

- Some students may need the lesson split into two days, including the homework in class time. I would work on deciding what a pest is on the first day, hang the posters and close with the sticky notes, then I would continue from step 9 the next day. They may require more guidance on re-assessing their initial perception of their pest/not a pest problems as well as finding non-standard but still useful solutions to pest problems.
- Some students may work better in slightly smaller groups where there is less competition. They may also benefit from first answering everything in their native language and then translating the answers. Labeling with pictures will also help.
- Some students may benefit from being assigned the task of finding a situation in which each of their pests is not a pest and vice versa. They may also want to research how that pest came to be there in the first place. Was it native before

humans altered the environment? Has it long been a cohabitant of human living spaces? Did humans introduce it and allow it to run wild?

- Students with less background knowledge in biology or local natural history would benefit from a lesson preceding this one on the habits of many of our local flora and fauna. This includes younger students (middle school age) as well as recent moves and ESL students.

Glossary:

1. **Arthropod:** an invertebrate with jointed appendages, a segmented body, and an exoskeleton
2. **Cerci:** paired appendages on the rear of many arthropods. Often serve as sensory appendages, but may be used as pincers or in mating.
3. **Damage:** injury or harm that reduces value (monetary or cultural) or usefulness.
4. **Elimination:** getting rid of entirely
5. **Environment:** the air, water, minerals, organisms and all other external factors surrounding and affecting a given organism at any time.
6. **Insectivore:** an animal whose primary source of nutrition is eating insects.
7. **Integrated:** coordinating separate elements so that they work together towards a common goal.
8. **Integrated Pest Management (IPM):** using what we know about the life cycles of pests to create an economical pest management plan, using a variety of techniques, with the least possible damage to humans and the environment
9. **Limiting Resource:** an environmental factor that limits the growth, abundance, or distribution of an organism or population.
10. **Management:** the science of controlling or regulating, in this case, reducing a population to a tolerable size.
11. **Naturalized:** an introduced species that has adapted to the local environment and now falsely appears to be native.
12. **Pest:** an organism that damages the environment or humans, or interferes with human activities.
13. **Species:** This is both the plural and singular referring to the most basic category of biological classification. (“Specie” refers to money, not a genetic category)
14. **Spp:** this is the scientific abbreviation for “several species.” It is used to indicate that we are discussing a group of closely related species that share a common generic name. For example, *Drosophila spp.* May include *Drosophila melanogaster*, *Drosophila buskii*, and *Drosophila funibris*.
15. **Ecological threshold:** the point at which small changes in external conditions cause large changes in the ecosystem.

Possible Lesson Extensions:

- Trace the history of an invasive pest. Where did it come from? How did it get here? What has made it successful here? Do we have similar native organisms? What have been the effects of this pest invading?
- Break down the species names – What are the Latin or Greek words in the names and what do they mean? Why might those words have been applied to this species? Look into the full scientific name of the species. Why are species names made up of two parts and not just the species epithet?
- Look at a related but non-pest species of one of our pests. Why is this species not a pest? What are some biological traits that make them similar and different? Is the location of the plant or animal important?
- Develop an IPM approach for the control of a mythical plant or animal or one from a fantasy or science fiction book the students are reading. Include limiting resources for organisms, the biotic and abiotic elements of their environment with which they interact, and what they need to live and reproduce as individuals and a species.
- With older or more advanced students, expanding on their “Three Pronged Management Method” to include a supporting argument for one of the types of pest management involving biological information on the pest and more detailed information on the environment we find it in.
- Have the students develop thresholds for a number of potential pests. A threshold is the number of organisms of a certain species that is deemed acceptable in a particular environment. In my house, the mouse threshold is zero, the ant threshold is three and the spider threshold is infinite. Once they have thresholds, have the students develop a system for monitoring for those pests and managing them if they reach that threshold. What would the student do if the pest far surpassed the decided threshold?

Resources:

Encyclopedia of Life: A free resource for information, images, videos, sounds, maps, classifications and more about the organisms on earth.

<http://eol.org/>

Nature on PBS: Videos and factsheets about animals.

<http://www.pbs.org/wnet/nature/category/episodes/by-animal/>

Sonoran Desert Museum: A catalog of information and images of plants and animals that occur in the Sonoran desert region.

https://www.desertmuseum.org/kids/online_fun.php

BugGuide.net: An online community of naturalists sharing information and images of arthropods.

<http://bugguide.net/node/view/15740>

CSU Extension: The educational outreach branch of Colorado State University.

<http://www.ext.colostate.edu/>

US Forest Service: Information on Fish, Wildlife, and Plants both native and invasive.

<http://www.fs.fed.us/science-technology/fish-wildlife-plants>

US Department of Agriculture: The national invasive species information center, information on plants, animals, and pathogens whose introduction is likely to cause harm.

<http://www.invasivespeciesinfo.gov/index.shtml>

University of California Davis Extension: The educational outreach branch of the University of California Davis.

<http://www.ipm.ucdavis.edu>

A Classroom InPestigation: A week long lesson plan for 3rd to 5th graders upon which this lesson plan is based, written by Ian Parker Renga (University of Colorado), Deborah J. Young (Colorado State University), and Carrie Foss (Washington State University). http://www.extension.org/sites/default/files/ipm_curriculum.pdf

This curriculum was written and developed by Amber Williams to meet the requirements for the degree of Master of Science in the Department of Bioagricultural Sciences and Pest Management, Colorado State University, 2015. All lessons in this resource, as well as updates and links, can be accessed online at <http://ipm.agsci.colostate.edu/>. We sincerely appreciate all of those who helped in the development and preparation of the curriculum, especially the students and teacher at Mesa County School District, Grand Junction, Colorado.



Pavement Ant *Tetramorium caespitum*: You found a single pavement ant crawling along the sidewalk on your way to school. Pavement ants are omnivores, native to Europe, and live in colonies. Within each colony there is a queen, workers, and in the summer alates or winged ants are produced. This is a worker. Workers tend to the queen, hunt, scavenge, and defend the colony.



Pavement Ants *Tetramorium caespitum*: You observed several pavement ants crawling on a sticky table in the lunchroom. Pavement ants are omnivores, native to Europe, and live in colonies. Within each colony there is a single queen, many workers, and in the summer alates or winged ants are produced. You observe workers which are scavenging.



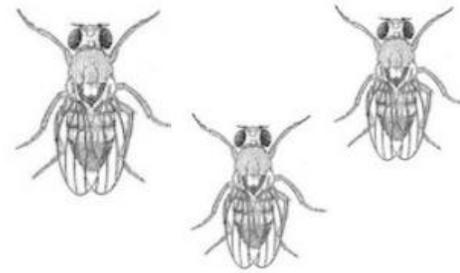
Miller Moth *Euxoa auxiliaris*: A miller moth flew out of the door jamb of your front door when you opened it this morning. The caterpillars are known as army cutworms, they eat a wide variety of young plants, cutting them off at ground level, making them crop pests. The adults provide a nutrient rich food source for birds and grizzly bears. The adult moths are migratory natives in the Rockies, moving into the mountains with warm weather and back to the eastern plains in the fall. Adult moths are considered nuisance pests.



Butterfly *Lycaenidae* spp: A blue butterfly that is only about an inch across landed on your arm during afternoon recess. The larvae eat the leaves of buckwheat and legumes (peas, beans, alfalfa and more) and the adults are common native floral visitors across the western US. You can only see the blue flashes when the butterfly flaps its wings, the bottom sides of the wings are dusty brown and speckled.



Bed bug *Cimex lectularius*: A classmate of yours has red bumps on their arms and observed a bed bug crawling out of their backpack. Bed bugs are very difficult to detect and control (pesticide resistance is increasing) and may cause an allergic reaction. Bed bugs have cohabited with humans for centuries. They have once again become common throughout the U.S.



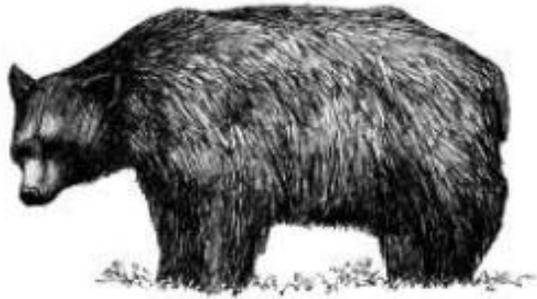
Fruit flies *Drosophila* spp: You find a swarm of fruit flies hovering around a banana peel on the floor of the lunchroom. Fruit fly maggots feed on decaying plant matter. They have very short generation times, which can result in rapid population growth. They are a popular model organism for genetic and evolutionary studies. Several species are now common worldwide



Mosquito *Culicidae* spp: A female mosquito lands on your arm while you wait for the bus. Female mosquitoes need a blood meal to lay eggs while males only drink nectar and other juices from plants. Mosquito larvae are aquatic and breathe through a straw like structure called a siphon. Larvae are a major food source for many aquatic organisms like fish. Some species of mosquito can transmit diseases. The U.S. is host to native and a few non-native species.



Wolf Spider *Hogna carolinensis*: You find a wolf spider hiding between a drain spout and the wall outside a classroom. They can be up to an inch in size and the females carry their egg sacs around with them until they hatch. Most spiders are non-aggressive and not dangerous unless they feel threatened. This is a widespread native species around the United States.



Black Bear *Ursus americanus*: You saw a black bear near some trashcans on your way to school. Black Bears are omnivores, feeding on whatever foods are most available, and are native to high elevation North American forests. They are large and powerful, so they do not tend to have much fear.



Raccoon *Procyon lotor*: You spied a raccoon walking along the side of a creek during a hike. Raccoons are native to North America. They are omnivorous and usually nocturnal. Raccoons are noted for their intelligence and adaptability. You may have seen “raccoon proofing” kits for garbage cans and chimneys in your local hardware store.



Big Brown Bat *Eptesicus fuscus*: You noticed guano by the school door. Bats may pose a health threat to humans because of viruses they sometimes carry. These bats are insectivores and eat winged insects at night. During the day these bats roost in old trees, caves, or man-made structures. This is a native bat species.



Big Brown Bat *Eptesicus fuscus*: You spotted a few bats one evening flying around eating insects like mosquitoes, this is because these bats are insectivores. They also eat moths, beetles and wasps. These bats are native to North America and often roost in caves, dead trees, and man-made structures.



European Paper Wasp *Polistes dominula*: You saw a paper wasp building a nest near the door to the school. Paper wasps are omnivorous, feeding on nectar and caterpillars. Their nests are made of wood fiber mixed with saliva. Some people are highly allergic to wasp stings. Wasps can sting multiple times because their modified ovipositors are not barbed but this species is less aggressive than hornets or yellow jackets. These wasps are an invasive species from Europe.



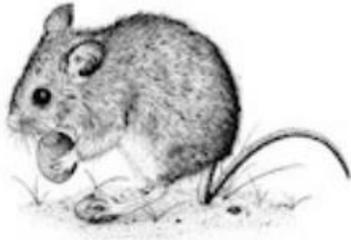
Honeybee *Apis mellifera*: A bee was buzzing around a light in your classroom. Honeybees can only sting once, their stinger is a modified ovipositor with barbs on the end that hook into the skin. This means that when a bee stings something it will not survive the encounter as the stinger is still attached to its internal organs. Some people are extremely allergic to bee stings. Honeybees were originally imported from Europe and are vital to U.S. crop production of fruits and vegetables.



Honeybee *Apis mellifera*: You saw bees landing on some flowers growing next to the school. Honeybees can only sting once, their stinger is a modified ovipositor with barbs on the end that hook into the skin. This means that when a bee stings something it will not survive the encounter as the stinger is still attached to its internal organs. Some people are extremely allergic to bee stings. Honeybees were originally imported from Europe and are vital to U.S. crop production of fruits and vegetables.



Deer Mouse *Peromyscus* spp: You saw a mouse run across the road into a bunch of wild grass. These mice are native across North America and are important prey for snakes, owls, skunks, coyotes and foxes. Deer mice carry diseases such as hantavirus (most commonly transmitted by contact with mouse feces). Hantavirus can be deadly to humans. Mice can also cause structural damage to homes.



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House Sparrow *Passer domesticus*: You saw one hopping around under a picnic table eating crumbs. The house sparrow is now found worldwide, although it is native to Europe, the Mediterranean and Asia. Its preferred food is grains, but it will eat many other things, including insects, if available. It may attack native birds in competition over food and nesting sites.



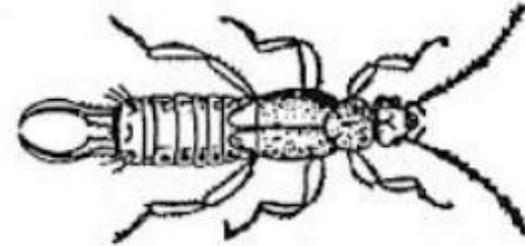
House Sparrow *Passer domesticus*: You saw one fly into a nest above the school door. It pooped on the door handle. The house sparrow is now found worldwide, although it is native to Europe, the Mediterranean and Asia. Its preferred food is grains, but it will eat many other things, including insects, if available. It may attack native birds in competition over food and nesting sites.



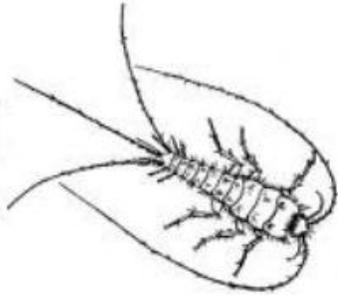
Northern Flicker *Colaptes auratus*: You saw one pecking at a wood beam at a friend's cabin. This is a widespread woodpecker native to North America that feeds primarily on insects, particularly ants and beetles, with a few berries thrown in. Woodpeckers will peck on a wood house if it is infested with insects. They usually nest in holes in trees, and occasionally on the ground.



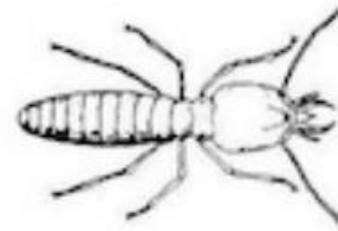
Northern Flicker *Colaptes auratus*: You saw one in a tree near your school. This is a widespread woodpecker native to North America that feeds primarily on insects, particularly ants and beetles, with a few berries thrown in. Woodpeckers will peck into a wood house if it is infested with insects. They usually nest in holes in trees and occasionally on the ground.



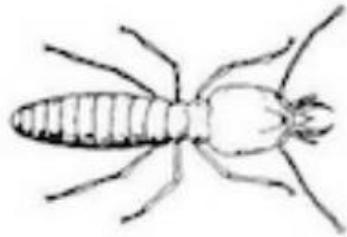
European Earwig *Forficula auricularia*: You saw many earwigs crawling on plants in the vegetable garden. Earwigs are omnivores, eating a wide variety of plants and insects. They use their cerci (the pincers) to capture prey, for mating, and in defense. This species was introduced to North America from Europe in 1910. Earwigs do not crawl into ears.



Silverfish: You saw some running along the floor next to the drinking fountain. Silverfish eat the starches present in book bindings, carpet, sugar, dandruff and more. They are most likely nonnative, but have spread with human inhabited areas because of our moist sinks and showers that mimic their natural habitat. They are tiny and most likely to be seen scampering down the drains right as you turn the lights on.



Eastern Subterranean Termite *Reticulitermes flavipes*: You saw some in a rotting log at the park. Termites mate for life, each termite mound contains at least one female and her mate as well as worker and soldier caste termites. Termites eat wood with the help of mutualistic bacteria in their gut to assist in digestion. This species is native across the central and Eastern U.S. and is responsible for most termite damage to structures.



Eastern Subterranean Termite *Reticulitermes flavipes*: You saw a few in a corner of your classroom. Termites mate for life, each termite mound contains at least one female and her mate as well as worker and soldier caste termites. Termites eat wood with the help of mutualistic bacteria in their gut to assist in digestion. This species is native across the central and Eastern U.S. and is responsible for most termite damage to structures.



Purslane *Portulaca oleracea*: You saw some plants growing in the cracks in the school parking lot. Purslane was introduced from Europe, but is now naturalized in the United States. In some places it is eaten in salads, soups, and stews. It is a part of traditional medicine in many cultures, and provides good hardy ground cover. Purslane is able to tolerate very poor soil and water conditions.



St. John's Wort *Hypericum perforatum*: You saw these pretty yellow flowers growing in a neighbor's garden. Also called goatweed or Klamath weed, St. John's Wort is native to Europe, the Middle East and Asia. It uses both sexual and vegetative reproduction and the seeds can survive for years in the soil. Large doses, such as those taken in by grazing animals, may cause severe skin irritation and mania, particularly in light skinned animals.



St. John's Wort *Hypericum perforatum*: You noticed many plants along the road on the way to school. Also called goatweed or Klamath weed, St. John's Wort is native to Europe, the Middle East and Asia. It uses both sexual and vegetative reproduction and the seeds can survive for years in the soil. Large doses, such as those taken in by grazing animals, may cause severe skin irritation and mania, particularly in light skinned animals.



Dandelion *Taraxacum* spp: You saw many plants growing in the cracks in the sidewalk at school. While the old leaves are quite bitter, young dandelion leaves are edible and can be used in salads. Dandelions attract many pollinating and flower visiting insects such as bees and butterflies. Various dandelions are native across the Northern Hemisphere.



Dandelion *Taraxacum* spp: You saw a plant growing in the city park. While the old leaves are quite bitter, young dandelion leaves are edible and can be used in salads. Dandelions attract many pollinating and flower visiting insects such as bees and butterflies. Various dandelions are native across the Northern Hemisphere.

Pest:	Your IPM Method	Pest Control Agency Method	DIY Method	IPM Agency Method
What is the method?				
In what situations is this method appropriate?				
Why?				

In what situations is this method inappropriate?				
Why?				
Are there any changes you would make to your method based on the internet information? Why?				

